# Unit 5 · Second Law of Thermodynamics

WORKSHEET

Full marks 33

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 33

## 1 Key words [4]

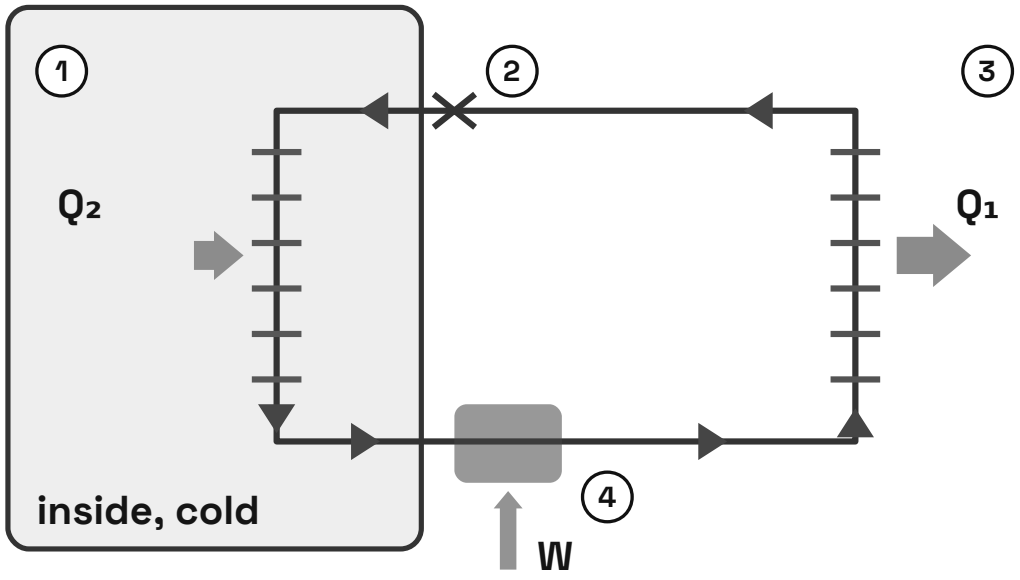
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

| | | | | |
|---|---|---|---|---|
| **carburetor** | **Carnot's engine** | **coefficient of performance** | **compression ratio** | **enthalpy** |
| **entropy** | **heat engine** | **Otto cycle** | **refrigerator** | **thermal efficiency** |

A device that turns heat into mechanical work, using a hot source and a cold sink, is a _____. The ratio of the work it does to the heat it takes from the source is its _____. No heat engine working between two temperatures can be more efficient than _____. A heat engine run in reverse, using work to move heat from a cold place to a warm one, is a _____; the heat it takes from the cold body divided by the work done is its _____. The ideal cycle of a petrol engine is the _____, and its efficiency depends on its _____. The heat given reversibly to a system divided by its absolute temperature is its change in _____.

## 2 Label the diagram [2]

The diagram shows the loop of the refrigerant in a refrigerator. Write the label that belongs in place of 1 to 4. Each carries 0.5 mark.




1. _____ 2. _____

3. _____ 4. _____

## 3 Multiple choice [5]

Choose the correct option for each of the following questions.

**i.** The Kelvin–Planck statement of the second law says that: [1]

**a.** heat can't flow from a cold body to a hot one, even with work done
**b.** no engine working in a cycle can turn all the heat it takes in into work
**c.** energy can be neither made nor destroyed
**d.** the entropy of an isolated system always falls

**ii.** A Carnot engine works between 450 K and 300 K. Its efficiency is: [1]

**a.** 50% **b.** 33%
**c.** 67% **d.** 150%

**iii.** An ideal refrigerator keeps its inside at 270 K in a room at 300 K. Its coefficient of performance is: [1]

**a.** 0.9 **b.** 1.1
**c.** 9 **d.** 10

**iv.** The efficiency of an ideal petrol (Otto) engine with $\gamma = 1.4$ rises: [1]

**a.** when the spark plug fires earlier
**b.** when its compression ratio is raised
**c.** when the cylinder is made larger at the same compression ratio
**d.** when more fuel is burned in each stroke

**v.** When a hot cup of tea cools in a room: [1]

**a.** the total entropy falls **b.** the total entropy stays the same
**c.** the total entropy rises **d.** the tea's entropy rises

## 4 Short answers [7]

Write short answers to the following questions.

**a.** Why does a diesel engine need no spark plug? [2]

**b.** Write any two differences between a petrol engine and a diesel engine. [2]

**c.** An ideal refrigerator works between 270 K and 300 K. How much work is needed to take 900 J of heat out of its inside? How much heat goes into the room? Why does a real refrigerator need more work than this? **[3]**

## 5 Long answer **[4]**

Write a long answer to the following question.

Describe the four steps of Carnot's cycle, saying in each where the cylinder stands, whether heat goes in or out, and what happens to the gas's temperature.

## 6 Numerical problems **[8]**

Solve the following problems. Show your working.

**a.** An engine takes in 2400 J of heat from a source at 527 °C in each cycle and gives out 1500 J to a sink at 27 °C. Find i. its efficiency, ii. the efficiency of a Carnot engine working between the same temperatures, and iii. how much work that Carnot engine would do with the same 2400 J. **[4]**

**Answer:**

**b.** 0.50 kg of ice at 0 °C melts in a room at 20 °C, taking all its heat from the room. Find i. the change in the entropy of the ice, ii. the change in the entropy of the room, and iii. the change in the total entropy. Is the melting natural? (Specific latent heat of fusion of ice = 334 000 J/kg.) **[4]**

**Answer:** _____

## 7 Think **[3]**

Someone suggests cooling a closed kitchen on a hot day by leaving the refrigerator's door open. Would the kitchen get cooler? Explain using the energy flows of a refrigerator.

_____

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_____

_____

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## 8 Activity: Watch heat flow downhill (not marked)

Fill one glass with hot water and one with cold water. Put a thermometer in each, then stand the cold glass in a bowl of the hot water. Read both every 2 minutes.

| Time (min) | Hot water (°C) | Cold glass (°C) |
|---|---|---|
| 0 | | |
| 2 | | |
| 4 | | |
| 6 | | |
| 8 | | |

Which way did the heat flow? Did it ever flow back?

_____

_____